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(54) Method of and apparatus for identifying a coin

(57) To provide an extremely highly reliable coin identifying method and an apparatus, capable of exactly identifying a clad coin without having to pay attention to what kind it belongs to. It employs an eddy current loss detecting type magnetic sensor comprising coils, which said magnetic sensor being formed by arranging an exciting coil and a reflection detecting coil on the same side with respect to a coin to be identified. The method includes exciting the exciting coil by synthesizing together at least three kinds of frequencies, calculating an attenuation rate by dividing, with an output of the reflection detecting coil when not having a coin, an output difference of the reflection detecting coil between a time having a coin and a time not having a coin in relation to various frequencies, thereby performing the coin identification.

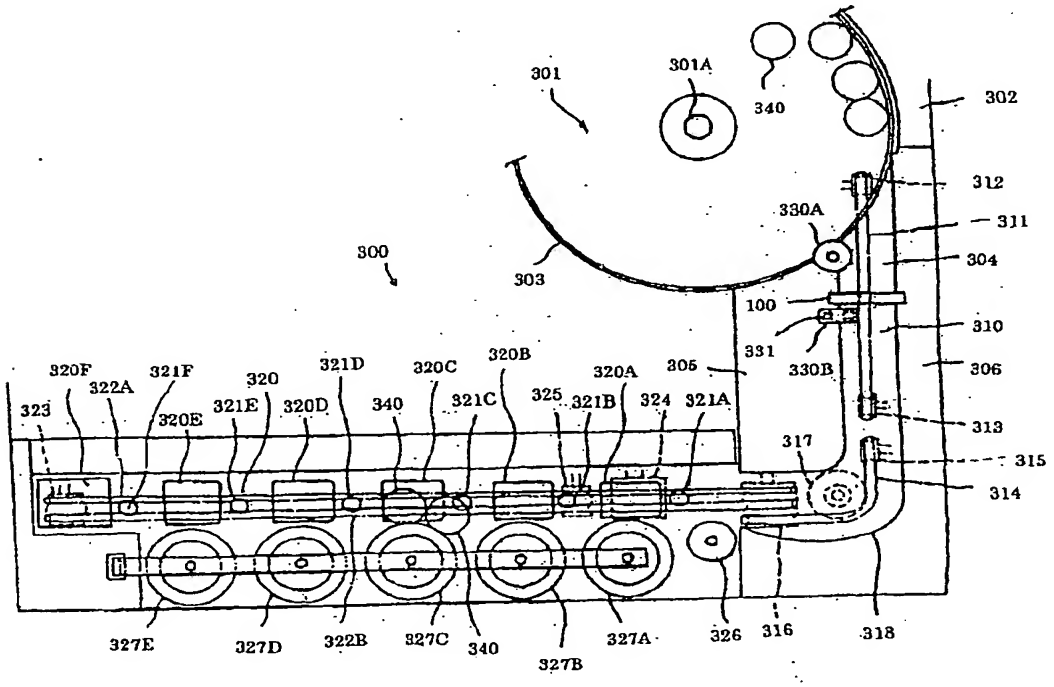

FIG. 2

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an extremely highly reliable method and apparatus for identifying a coin, which is suitable for use in a coin handling machine such as a coin sorting machine, a coin receiving machine and a coin packing machine, and is also capable of exactly identifying what kind a coin belongs to and whether a coin is a true one.

2. Description of the Related Art

[0002] As a prior art, there has been known a coin identifying apparatus such as that which was disclosed in Japanese Patent No.2567654. Such kind of coin identifying apparatus is capable of exciting an oscillating coil with a high frequency and a low frequency, obtaining a sum of the output attenuations of various frequencies fed from a data receiving coil, identifying coins in accordance with different outputs indicating that a coin is a clad coin (a bimetallic coin) having its entire surface formed by an identical material or indicating that a coin is made of only single one material and single one structure. Here, what is meant to be a clad coin is an example shown in FIG.1, which is a three-layer structure (front surface, immediate body and back surface) made of different materials, using aluminium (Al) or copper as its core layer which is covered on both sides thereof by a copper-nickel (CuNi). In general, an output signal indicating a copper-nickel coin will have a different signal level from that of an output signal indicating a clad coin which is made of a copper-nickel only on the surface thereof.

[0003] However, with the above conventional apparatus, there is a problem that it is impossible to exactly identify a clad coin. This is because there may be existing other kind of a coin which is made of single one material but which will produce the same output level as that of a clad coin made of a copper-nickel only on the surface thereof.

SUMMARY OF THE INVENTION

[0004] The present invention has been accomplished in view of the above problems, its object is to provide an extremely highly reliable coin identifying method and an apparatus therefor, capable of exactly identifying a clad coin without having to pay attention to what kind it is.

[0005] The present invention relates to (a method and) an apparatus for identifying a coin. The present invention is the following manner. Namely, said method employs an eddy current loss detecting type magnetic sensor comprising coils, which sensor being formed by arranging an exciting coil and a reflection detecting coil on the same side with respect to a coin to be identified, said method includes exciting the exciting coil by synthesizing together at least three kinds of frequencies, calculating an attenuation rate by dividing, with an output of the reflection detecting coil when not having a coin, an output difference of the reflection detecting coil between a time having a coin and a time not having a coil in relation to various frequencies, alternatively or further, dividing the attenuation rates at the above various frequencies with an attenuation rate at a specific frequency so as to effect a standardization, thereby performing the coin identification. If the above coin identification is further performed in accordance with an output of a transmission detecting coil provided facing the above exciting coil and the reflection detecting coil, the above object may be achieved more effectively.

[0006] Further, the present invention provides the following means including an exciting coil to be excited by synthesizing together at least three kinds of frequencies, a reflection detecting coil wound around the same core for winding the exciting coil, a separating means for separating a plurality of the frequency components from the output of the reflection detecting coil. an identifying means capable of operating in accordance with a plurality of the frequency components separated by the above separating means, dividing with an output not having a coin an output difference of the reflection detecting coil between a time having a coin and a time not having a coin in relation to various frequencies, thereby calculating an attenuation rate, alternatively or further, dividing the attenuation rates at the above various frequencies with an attenuation rate at a specific frequency so as to effect a standardization, thereby performing the coin identification. If the above separating means comprises a band pass filter, a full wave rectifying circuit, a low pass filter and an A/D converter, and if the above identifying means is made capable of performing a calculation with the use of a digital value, the above object may be achieved more effectively.

[0007] Still further, the present invention provides the following means including an exciting coil to be excited by synthesizing together at least three kinds of frequencies, a reflection detecting coil wound around the same core for winding the exciting coil, a transmission detecting coil wound around a detecting core facing the above exciting coil, a separating means for separating a plurality of the frequency components from the output of the reflection detecting coil, an identifying means capable of operating in accordance with a plurality of the frequency components separated by the above separating means, dividing with an output of the reflection detecting coil when not having a coin an output difference of the reflection detecting coil between a time having a coin and a time not having a coin in relation to various frequencies, thereby calculating an attenuation rate, while at same time operating in accordance with an output of the transmission detecting coil to detect the outer appearance of the coin so as to identify the same.

[0008] The present invention relates to a method of identifying a coin, wherein said coin is constructed by three layers of a front surface, an immediate body and a back surface, and said front surface is acted by at least a first frequency, said immediate body is acted by at least a second frequency and said back surface is acted by at least a third frequency, by using at least said three frequencies.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] In the accompanying drawings:

FIG.1 is an outer appearance view illustrating one example of a clad coin;
FIG.2 is a brief construction illustration of the coin sorting machine;
FIG.3 is a structural view schematically illustrating a wire arrangement showing one example of a magnetic sensor used in the present invention;
FIG.4 is an arrangement structural view indicating one example of a detecting core and an exciting core for use in the magnetic sensor;
FIG.5 is a view indicating a condition showing how the detecting core and the exciting core are wound by a transmission detecting coil, an exciting coil and a reflection detecting coil;
FIG.6 is a view indicating an example showing how a shield plate is provided in the magnetic sensor;
FIG.7 is a view showing an outer appearance of the magnetic sensor;
FIG.8 is a view of a condition indicating how a coin is identified in the magnetic sensor;
FIG.9 is a block diagram indicating an example of a circuit used in the coin identifying apparatus of the present invention;
FIG.10 provides waveform graphs indicating operation examples of the present invention;
FIG.11 provides waveform graphs indicating operation examples of the present invention;
FIG.12 is a graph indicating examples of the characteristics of the reflection detection;
FIG.13 is a graph indicating examples of the characteristics of the transmission detection;
FIG.14 is a graph indicating examples of the characteristics of the reflection detection;
FIG.15 is a graph indicating examples of the characteristics of the transmission detection; and
FIG.16 is a structural view schematically illustrating a wire arrangement showing another example of a magnetic sensor used in the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] First, a coin sorting machine 300 will be explained with reference to FIG.2, and the present invention is applicable to the coin sorting machine 300.

[0011] FIG.2 illustrates an embodiment of a coin sorting machine, a rotary circular plate 301 is freely rotatably supported on a base plate 302 by means of a shaft 301A. The outer periphery portion of the rotary circular plate 301 is covered by a circumferential wall 303. Then, on the base plate 302 there is fixed a bottom plate 304 whose upper surface forms an identical plane with the upper surface of the rotary circular plate 301. The bottom plate 304 is provided with two coin passage wall members 305 and 306, and is further formed with a coin stop passage 310, whose downstream side is provided with several coin sorting holes 320A, 320B, ... 320F, thereby forming a coin sorting passage 320. The inlet side of the other passage wall member 305 is provided with a roller 330A which is located on the circumferential edge of the rotary circular plate 301. On the other hand, the inlet side of the other passage wall member 306 is disposed along a straight line direction of the circumferential edge of the circular rotary plate 301. Further, the passage wall member 305 is formed with a notch 330B so that a coin stopping member 331 is allowed to escape therethrough.

[0012] On the other hand, at a front end in a coin sending direction of the coin stop passage 310, there is provided a magnetic sensor 100 which is used as a first counting means and employs a magnetic sensor for magnetically detecting a coin. A coin 340 passing therethrough will be detected, while the denomination of the money and the number of the coins will be detected and counted by a money denomination discriminating section (not shown). Moreover, the upper surface of the coin stopping member 331 is protruding from the upper surface of the bottom plate 304, and is connected through a connecting piece member of a solenoid which is not shown in the figure. Then, at a time when the solenoid is not excited, by virtue of an internal spring and in a manner shown by a solid line in the figure, the passing of a coin will not be hampered since the stopping member will be caused to retract to move into the notch of the passage wall member 305. However, at a time when the solenoid is excited, as shown by a chain line in the figure, the movement of the coin 340 will be stopped since the stopping member is protruding on to the coin passage way. In addition, on the upper surface of the coin stop passage 310, there is provided an introduction belt 311 extending from an inlet entrance above and over the rotary circular plate 301. Such introduction belt 311 is wound around pulleys 312 and 313. Then, the pulleys 312, 313 are provided at predetermined height positions (at which the belt 311 can get contact with the upper surface of the coin 340 with a predetermined pressure, and can send or feed the coin 340) with respect to the upper surface of the coin stop passage 310.

[0013] Nevertheless, the front portion of the transporting belt 314 is wound around the pulleys 315, 316, and is bent by a right angle towards a direction of the coin sorting passage 320, by virtue of a pulley 317. Further, the end of the passage wall member 306 has a bent side

surface 318 capable of guiding the coin 340 to cause it to move along a bent portion of the transporting belt 314.

[0014] On the other hand, on the coin sorting passage 320 of the bottom plate 304, there are formed sorting groove holes 320A, 320B, ... ,320F which are arranged in the order beginning with a hole for passing a smallest diameter coin and ending with a hole for passing a largest diameter coin. In front of the sorting groove holes 320A, 320B, ... ,320F, there are provided magnetic sensors 321A to 321F which are used as second detecting means for magnetically detecting the passing of the coins 340. Further, on the upper portions of the sorting groove holes 320A to 320F, there are provided straight linear sending belts 322A and 322B each having a circular cross section. One of the sending belts 322A and 322B is wound around a pulley 323, while the other of them is wound around a pulley 316 located on the downstream side of the transporting belt 314. Here, reference numeral 324 is used to represent a guide roller which is located on the upper portions of the sorting groove holes 320A, 320B, ... 320F, for preventing an upward floating of the sending belts 322A and 322B, and for guiding the movement of the belts 322A and 322B in the horizontal direction. Reference numeral 325 is used to represent a pulley located on the middle portions of the sorting groove holes 320A, 320B, ... 320F, for preventing an upward floating of the sending belts 322A and 322B, and for preventing the movement of the belts 322A and 322B in the horizontal direction. Moreover, reference numeral 326 is used to represent a positioning roller for guiding and positioning the coins 340 in order that the coins 340 may be sent to the formal positions on the sorting groove holes 320A, 320B, ... ,320F. Reference numerals 327A to 327E are used to represent reference rollers having the same diameters and the same shapes, which are provided on side portions corresponding to various sorting holes 320A to 320E, capable of restricting one side position of each coins 340, and deciding a passing rail with respect to the sorting holes 320A to 320E. Therefore, these reference rollers 327A to 327E are arranged to be in parallel with the belts 322A and 322B. With respect to this, the positioning roller 326 is located in a manner such that the outer periphery surface thereof is positioned in front of the reference rollers 327A to 327E, as shown in FIG.2, while the bent side surface 318 of the passage wall member 306 is located further before the outer periphery surface of the roller 326. For this reason, coins below the transporting belt 314 is allowed to get in contact with the bent side surface 318 so as to be guided to gradually change its moving direction under the transporting belt 314 and at the same time to move to a position under the pulley 316. At this moment, the coin gets in contact with the periphery surface of the positioning roller 326 so that its position is determined, and it is moved in parallel with the belts 322A and 322B, so as to come into contact with the reference rollers 327A to 327E during its movement.

[0015] On the other hand, in the vicinity of the reference roller 327A, the belts 322A and 322B are movably guided in the horizontal direction by virtue of the guide roller 324, while its horizontal movement back and forth is restricted by the pulleys 316, 325. Accordingly, there is no sliding movement between the coin 340 and the belts 322A and 322B, the change in its advancing movement caused by a contact between the coin and the periphery surface of the reference rollers will cause a deflection in the horizontal direction between the pulleys 316and 325 of the belts 322A and 322B. A restoring force of the belts 322A, 322B caused due to such a deflection may in contrast serve as a coin's pressing force to be exerted on the reference rollers 327A to 327F, while the coin itself will be moved along the periphery surfaces of the reference rollers 46A to 46E. After that, as soon as the coin arrives at the most outwardly protruding points on the outer periphery surfaces of the reference rollers 327A to 327E (a position where the guide roller 324 is provided, shown in FIG.2), the coin will be positioned on to the sorting groove hole 320A. If it is a kind of coin corresponding to the sorting groove hole 320A, since the size of the most outwardly protruding point on the periphery surface of the reference roller 327A and the size of an opposite edge portion of the sorting groove hole 320A are slightly larger than the diameter of the coin of this kind of money, a coin edge portion located opposite to the reference roller 327A will be deviated from the bottom plate 304, so that the coin will be quickly dropped into the sorting groove hole 320A, by virtue of a pressing force of the guide roller 324 and the belts 322A, 322B, so as to be received into a temporary retaining box or a money safe box (both of them are not shown in the figure). The coins not coincident with the sorting groove hole 320A will be further moved along the surface of the reference roller 327A, by virtue of a pressing force of the belts 322A, 322B and a horizontal restoring force, so as to be returned to its moving path before coming into contact with the reference roller 327A. At this moment, the coin gets into contact with the next reference roller 327B and receives the same motion as the above, so as to be dropped into a corresponding groove hole of the sorting groove holes 320B to 320F, thereby receiving coin into a money safe box (not shown). Nevertheless, a restriction on the horizontal movement of the belts 322A and 322B with respect to the second one onwards along the sorting groove holes 320B to 320F, may be performed with the use of the pulley 325 positioned before or after the sorting hole. Further, the sizes of the sorting groove holes 320A to 320F in a direction orthogonal to the belts 322A, 322B are slightly smaller than the diameters of the coins.

[0016] FIG.3 is used to schematically indicate the structure of a magnetic sensor 100 made according to the present invention. A transmission detecting coil 11 is wound around a plate-like detecting core 10 shown in FIG.4, so that a detection signal DT1 may be outputted from the transmission detecting coil 11. Further, as shown in FIG.4, a plate-like exciting core 20 having two

notch portions on the upper center thereof is wound by an exciting coil 21, while a projection 22 located between the two notch portions is wound by a reflection detecting coil 23, so that a detection signal DT2 may be outputted from the reflection detecting coil 23. On the central portion of the magnetic censor 100, there is provided a passage 1 through which a coin to be detected is transported and is allowed to pass. The exciting coil 21 and the reflection detecting coil 23 are used to form an eddy current loss type magnetic sensor, with the detection thereof being referred to as a reflection detecting in the present invention. Nevertheless, the exciting coil 21 is excited by an excitation electric source 30, and a detection signal DT1 is outputted from the transmission detecting coil 11, while a detection signal DT2 is outputted from the reflection detecting coil 23. FIG.5 is used to indicate a condition where the transmission detecting coil 11 is wound around the detecting core 10, meanwhile the exciting coil 21 is wound around the exciting core 20, and the reflection detecting coil 23 is wound around the projection 22.

[0017] Further, FIG.6 is used to illustrate a condition where Permalloy shield plates 12 and 24 are mounted on the outsides of the detecting core 10 and the exciting core 20, with the shield plates 12 and 24 being used to shut off an external magnetism. Further, the magnetic sensor 100 of the present invention is formed as having a passage 1 whose surface is formed by a wear resistant material 2. The passage 1 is formed between upper and lower sensor sections, with the use of an integral molding treatment (3) as shown in FIG.7, which is a method disclosed by the applicant in Japanese Patent Laid-open No.9-73568. The exciting core 20 (an exciting coil 21, a reflection detecting coil 23) is received into the sensor lower portion molded into a U-like shape, while a detecting core 10 (a transmission detecting coil 11) is received into the sensor upper portion molded into a rectangular parallelepiped shape. A sensor case is formed by a ceramic, a PPS resin or the like, with the sensor upper portion and the sensor lower portion being separable from each other by using screw means. FIG.8 is used to indicate a condition in which the magnetic sensor 100 is being used to detect a coin, where a coin 200 is caused to pass through a passage 1 by means of a transporting belt 4, thereby performing the identification of the coin 200 when it is in passing.

[0018] FIG.9 is used to indicate an example showing an excitation electric source 30 and an detecting circuit (detecting a reflection) of the magnetic sensor 100. The excitation electric source 30 includes four oscillators 31, 32, 33 and 34 of different oscillating frequencies, with their frequency outputs (in this example, 2 KHz, 10 KHz, 50 KHz, 200 KHz) being added together in an adding amplifier 35 so as to be amplified, thereby exciting the excitation coil 21 of the magnetic sensor 100, with the use of the added excitation signal and by way of a driving circuit 36. The detection signal DT2 fed from the reflection detecting coil 23 of the magnetic sensor 100 is fed into four kinds of band pass filters (BPF) 41, 42, 43 and 44 by way of an amplifier 40, so as to be separated into the above different frequency components. Then, the separated different frequency signals are respectively passed through full wave rectifying circuits (51, 52, 53, 54) and low pass filters (LPF) (61, 62, 63, 64), so as to obtain direct current levels. Further, these different frequency signals are passed through A/D converters (71, 72, 73, 74), so as to be outputted as digital detection signals SG1, SG2, SG3, SG4. The detection signals SG1, SG2, SG3, SG4 are then fed to an identifying means which will be described later, thereby performing the coin identification. Moreover, the detection signal DT1 fed from the transmission detecting coil 11 is fed to the identifying means, so as to be used for detecting the outer appearance (diameter) of a coin. However, although in the present example, four kinds of different frequencies have been used, it is also possible to use three kinds of frequencies. At this time, they may be 2 KHz, 10 KHz and 50 KHz.

[0019] With regard to the above constitution, an example of an operation will be described. FIG.10 and FIG. 11 are used to indicate examples of several wave forms of the excitation signal and the detection signal. Here, in order to make a simplified description, the following explanation will be made using only two kinds of frequencies.

[0020] FIG.10 is used to indicate a process beginning with the excitation of the magnetic sensor 100 by synthesizing together several frequency components and ending with the separation of different frequency components of the detection signal. (A) of the figure is used to indicate an excitation signal of a low frequency, while (B) of the figure is used to indicate an excitation signal of a high frequency. These excitation signals are synthesized in an adding amplifier 35, and are applied through a driving circuit 36 to the exciting coil 21 of the magnetic sensor 100. Therefore, the synthesized signal applied to the exciting coil 21 will become that as shown in (C) of FIG.10. Then, the detection signal DT2 outputted from the reflection detecting coil 23 of the magnetic sensor 100 will become that as shown in (D) of FIG.10, which is a wave form corresponding to the excitation signal. Such signal will then be fed to band pass filters 41 to 44. Here, for example, only a low frequency signal as shown in (E) of the figure will be extracted corresponding to each band pass frequency. Nevertheless, although there has been described the synthesizing and separation of two kinds of frequency signals, the above description is also suitable for a case dealing with four kinds of frequency signals.

[0021] On the other hand, FIG.11 is used to indicate an example for processing a high frequency signal obtained by frequency-separating the detection signal DT2 fed from the magnetic sensor 100. (F), (G), (H) of the figure are used to indicate examples of the wave forms (at a time of stand-by) when there is no coin, while (I), (J), (K) of the figure are used to indicate examples of the

wave forms (at a time of detection) when a coin posses. Further, (F) and (I) of FIG.11 are respectively used to indicate examples of the wave forms fed from the band pass filters (41 to 44), (G) and (J) of the figure are respectively used to indicate examples of the wave forms fed from the full wave rectifying circuits (51 to 54), (H) and (K) the figure are respectively used to indicate examples of the wave forms fed from the low pass filters (61 to 64). The output signals shown in (H) and (K) of FIG.11 are converted into digital detection signals (SG1 to SG4) by A/D converters (71 to 74), so as to be used in coin identifying process carried out by an identifying means. Here, FIG.11(K') is an enlarged graph obtained by enlarging FIG.11(K) in the direction of the vertical axis. If "a" is used to represent an output signal level at a time of stand-by, and if "b" is used to represent a minimum value of an output signal level during the detection, an output attenuation (a - b) caused by a coin, may be converted into a standardized value in accordance with the output signal level a at a time of stand-by, and such standardized value is referred to as an attenuation rate (= (a - b)/a), and is used as a characteristic amount for coin identification. The identifying means is used to perform the coin identification with the use of such standardized value. Although there will occur some irregularities in output signal level due to some irregularities in the magnetic sensor 100 and the signal processing circuit, it is possible to absorb such irregularities by performing a standardization in accordance with the output signal level "a" as in the above manner. However, the identifying means is capable of performing a comparison between various characteristic amounts and determination ranges set in advance for each denomination of coin, thereby identifying whether a coin is true one or not.

[0022] FIG.12 is used to indicate an example showing some attenuation rates determined by detecting the reflection (detection signal DT2) of four kinds of coins of different structures, including an Al coin and a CuNi coin each having a monometal structure (a monomer structure), a CuNi/Al/CuNi three-layer coin having a bimetallic structure (a clad structure), and an Al/CuNi/Al three-layer coin. If a coin is made of a clad structure having a diameter of 26 mm and a thickness of 2 [mm], its front and back skin layers will each have a thickness of 0.5 [mm], while its middle core layer will have a thickness of 1 [mm]. In FIG.12, there are indicated plots according to six kinds of frequencies, but in the identifying apparatus it is not necessary to have six kinds of frequencies. Here, when in a high frequency, the attenuation rate will depend upon the material properties of the surface layer. When in a low frequency, the attenuation rate will depend also upon the material properties of the middle layer. For this reason, if the attenuation rates at the above four kinds of frequencies (2 KHz, 10 KHz, 50 KHz, 200 KHz) are compared with the criteria decided in advance, it is allowed to identify the above four kinds of coins. On the other hand, when the attenuation rate changes with temperature, a result will be like that as recited in Japanese Patent Laid-open No.9-73568. Namely, it is allowed to perform a temperature detection by making use of an electric resistance change caused by a temperature change of the exciting coil, so as to detect an ambient temperature and to carry out a correction in accordance with the ambient temperature. FIG.13 is used to indicate an example showing an attenuation rate depending on a transmission detection (detection signal DT1) of four kinds of coins having different structures shown in FIG.12. In a case of transmission detection, since an output attenuation rate has nothing to do with an arranging order of the layers, it is impossible to discriminate the above two kinds of the clad structures.

[0023] Further, FIG.14 and FIG.15 are respectively used to indicate examples showing attenuation rates of reflection detection and transmission detection of a coin which is formed by clamping a ferromagnetic material with a second layer. In FIG.14, when a ferromagnetic material is clamped as the second layer, an output is increased instead of being attenuated in a low frequency area (coming to a minus area). Therefore, it is understood that a related material is a ferromagnetic material. However, with respect to FIG.15, even when a ferromagnetic material is clamped as the second layer, an output at a low frequency area is attenuated (plus area in the graph). Therefore, it is not understood that the material is a ferromagnetic material by only the transmission detection.

[0024] In this way, although in the transmission detection it is not possible to detect a difference in the order of the layers of a coin having a clad structure, nor is it possible to detect a ferromagnetic material, such kinds of detections will be successful with the use of reflection detection. With such reflection detection, since the attenuation rate will decrease once there occurs a floating of a coin during the transportation thereof, it is required that a discrimination range must be made large in order to deal with the floating of the coin. However, if this is done, a result will be that a precision of identification will be decreased. In order to perform coin identification without causing a decrease in the precision, what is required is that various attenuation rates at various frequencies are divided by an attenuation rate at any optional frequency, thereby obtaining standardized values which are used to carry out the coin identification. Further, it is also allowed not to perform the above identification at discrete frequencies as described in the above, instead, it is required to store continuous output levels at various frequencies under a condition where the excitation frequencies are swept during a stand-by period, to stop the coin on the magnetic sensor, to sweep the excitation frequencies, to calculate continuous output level at each detected frequency, thereby obtaining a wave form of continuous attenuation rate for each frequency, thus performing the identification in accordance with such wave form.

[0025] FIG.16 is used to indicate a modified embodi-

ment (100A) of the magnetic sensor used in the present invention, in which the detecting core is divided into two sections, transmission detecting coils 11A and 11B are wound around the two divided cores, in a manner such that a coin transporting belt 4 may be easily passed through a passage 1.

[0026] Nevertheless, if the above reflection detection is combined with the transmission detection (for example, an attenuation rate at 200 KHz) for detecting the diameter (outer appearance), it is sure to further improve a precision in coin identification. Moreover, in order to stabilize signals, it is possible for a pre-amplifier to be contained within the magnetic sensor.

[0027] As described in the above, with the use of the coin identifying method and the apparatus according to the present invention, since it is possible to detect not only the material property of a coin, but also the layer structure thereof, it is sure to further improve an identifying capability for identifying true or false of a coin. Therefore, it is also exactly possible to identify a clad coin.

Claims

1. A method of identifying a coin, wherein said coin is constructed by three layers of a front surface, an immediate body and a back surface, and said front surface is acted by at least a first frequency, said immediate body is acted by at least a second frequency and said back surface is acted by at least a third frequency, by using at least said three frequencies.

2. A method of identifying a coin, characterized in that said method employs an eddy current loss detecting type magnetic sensor comprising coils, which said magnetic sensor being formed by arranging an exciting coil and a reflection detecting coil on the same side with respect to a coin to be identified, said method includes exciting the exciting coil by synthesizing together at least three kinds of frequencies, calculating an attenuation rate by dividing, with an output of the reflection detecting coil when not having a coin, an output difference of the reflection detecting coil between a time having a coin and a time not having a coin in relation to various frequencies, thereby performing the coin identification.

3. A method of identifying a coin, characterized in that said method employs an eddy current loss detecting type magnetic sensor comprising coils, which said magnetic sensor being formed by arranging an exciting coil and a reflection detecting coil on the same side with respect to a coin to be identified, said method includes exciting the exciting coil by synthesizing together at least three kinds of frequencies, calculating an attenuation rate by dividing, with an output of the reflection detecting coil when not having a coin, an output difference of the reflection detecting coil between a time having a coin and a time not having a coin in relation to various frequencies, dividing the attenuation rates at the above various frequencies with an attenuation rate at a specific frequency so as to effect a standardization, thereby performing the coin identification.

4. A method of identifying a coin according to Claim 2 or 3, wherein the above coin identification is performed in accordance with an output of a transmission detecting coil provided facing the above exciting coil and the reflection detecting coil.

5. An apparatus for identifying a coin, characterized in that said apparatus comprises an exciting coil to be excited by synthesizing together at least three kinds of frequencies, a reflection detecting coil wound around the same core for winding the exciting coil, a separating means for separating a plurality of the frequency components from the output of the reflection detecting coil, an identifying means capable of operating in accordance with a plurality of the frequency components separated by the above separating means, dividing with an output of the reflection detecting coil not having a coin an output difference of the reflection detecting coil between a time having a coin and a time not having a coin in relation to various frequencies, thereby calculating an attenuation rate, thus performing the coin identification.

6. An apparatus for identifying a coin, characterized in that said apparatus comprises an exciting coil to be excited by synthesizing together at least three kinds of frequencies, a reflection detecting coil wound around the same exciting core for winding the exciting coil, a separating means for separating a plurality of the frequency components from the output of the reflection detecting coil, an identifying means capable of operating in accordance with a plurality of the frequency components separated by the above separating means, dividing with an output of the reflection detecting coil not having a coin an output difference of the reflection detecting coil between a time having a coin and a time not having a coin in relation to various frequencies, thus calculating an attenuation rate, further, dividing the attenuation rates at the above various frequencies with an attenuation rate at a specific frequency so as to effect a standardization, thereby performing the coin identification.

7. An apparatus for identifying a coin according to Claim 5 or 6, wherein the above separating means

comprises a band pass filter, a full wave rectifying circuit, a low pass filter, and an A/D converter, the above identifying means is capable of performing a calculation with the use of a digital value.

8. An apparatus for identifying a coin according to Claim 5 or 6, wherein said frequencies are four kinds and are 2 KHz, 10 KHz, 50 KHz and 200 KHz.

9. An apparatus for identifying a coin, characterized in that said apparatus comprises an exciting coil to be excited by synthesizing together at least three kinds of frequencies, a reflection detecting coil wound around the same exciting core for winding the exciting coil, a transmission detecting coil wound around a detecting core facing the above exciting core, a separating means for separating a plurality of the frequency components from the output of the reflection detecting coil, an identifying means capable of operating in accordance with a plurality of the frequency components separated by the above separating means, dividing with an output of the reflection detecting coil when not having a coin an output difference of the reflection detecting coil between a time having a coin and a time not having a coin in relation to various frequencies, thereby calculating an attenuation rate, while at same time operating in accordance with an output of the transmission detecting coil to detect the outer appearance of the coin so as to identify the same.

10. An apparatus for identifying a coin according to Claim 9, wherein said detecting core is divided two portions and transmission detecting coils are respectively wound around said divided two portions.

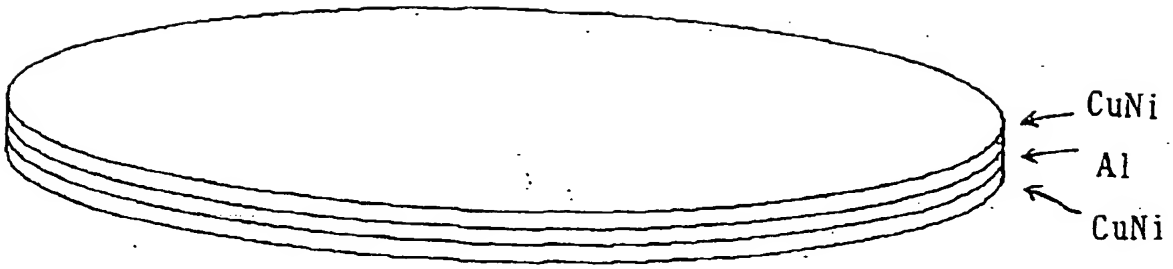

FIG. 1

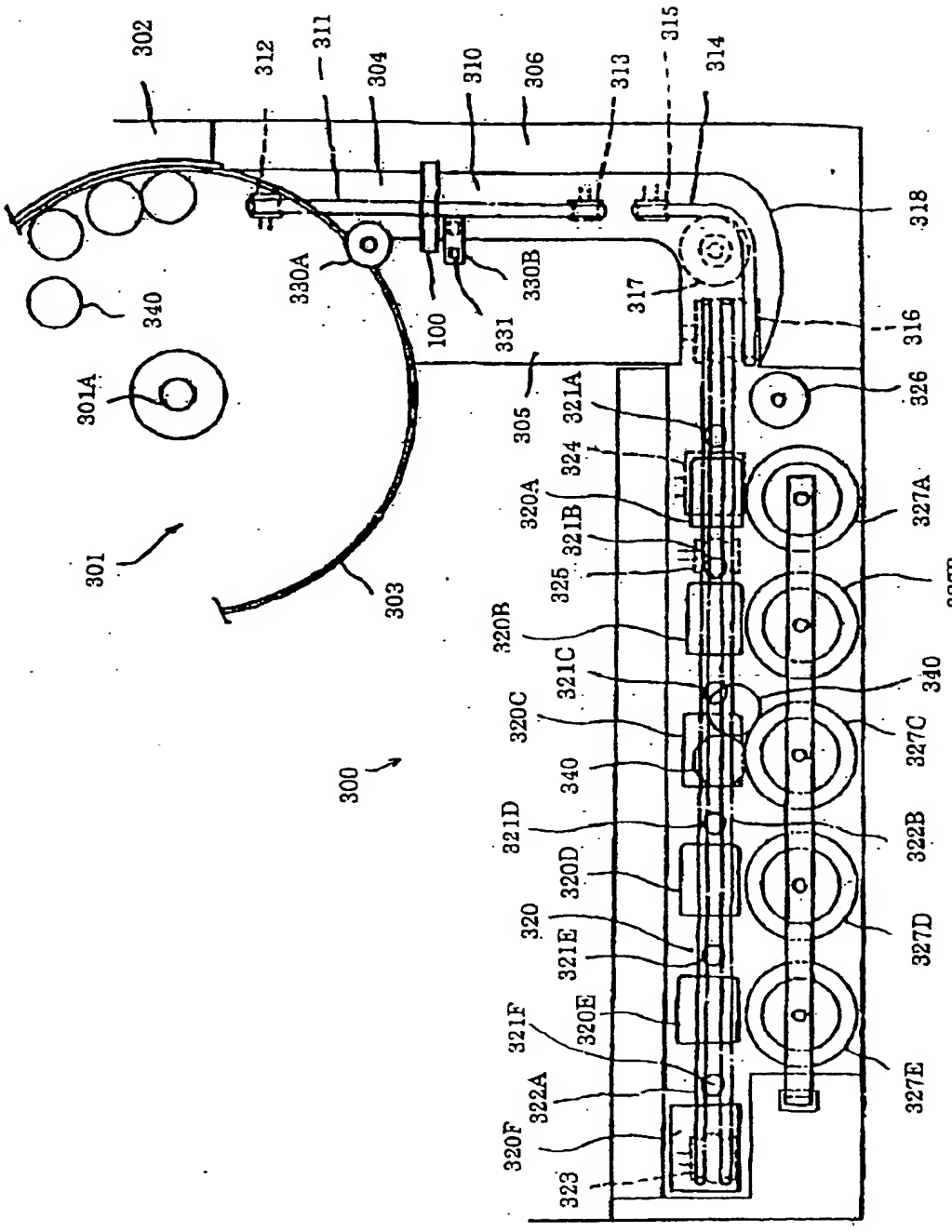
302
312
311
304
310
306
313
315
314
318
316
326
317
330A
330B
331
100
340
301A
301
303
305
321A
324
320A
321B
325
320B
321C
320C
340
300
321D
320D
320
321E
320E
321F
322A
320F
323
327A
327B
327C
322B
327D
327E

FIG. 2

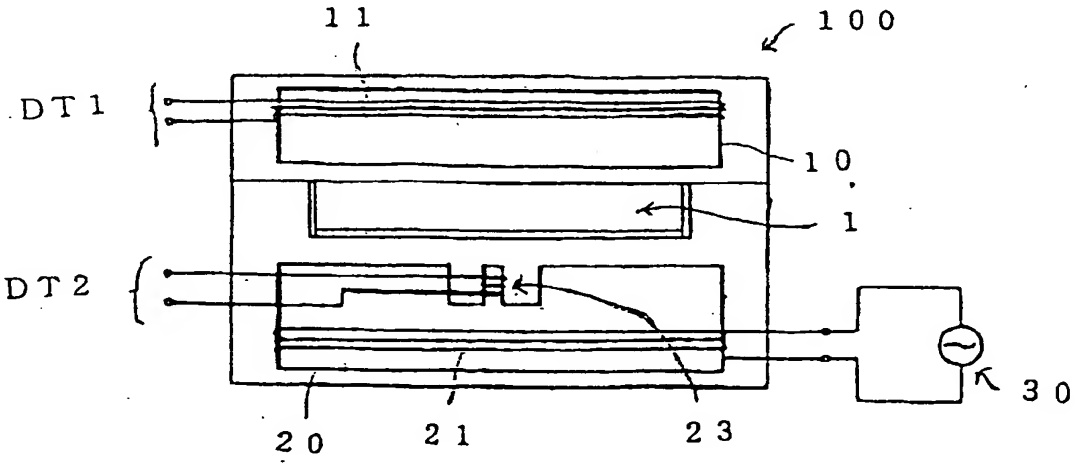

FIG. 3

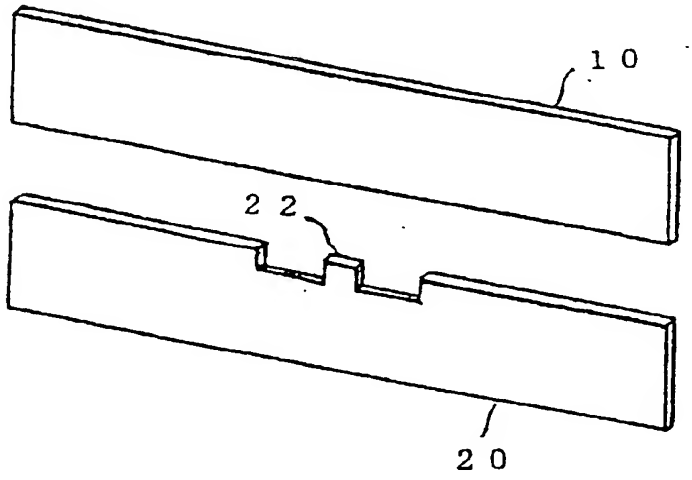

FIG. 4

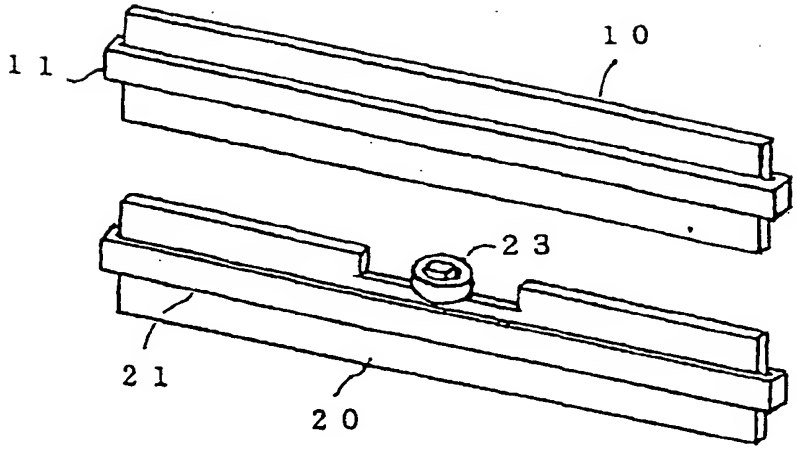

FIG. 5

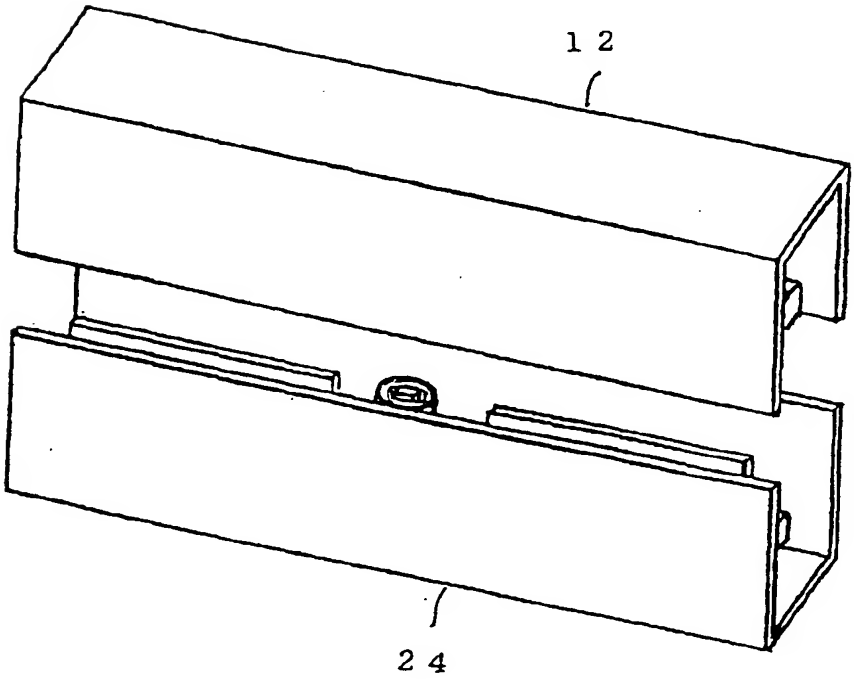

FIG. 6

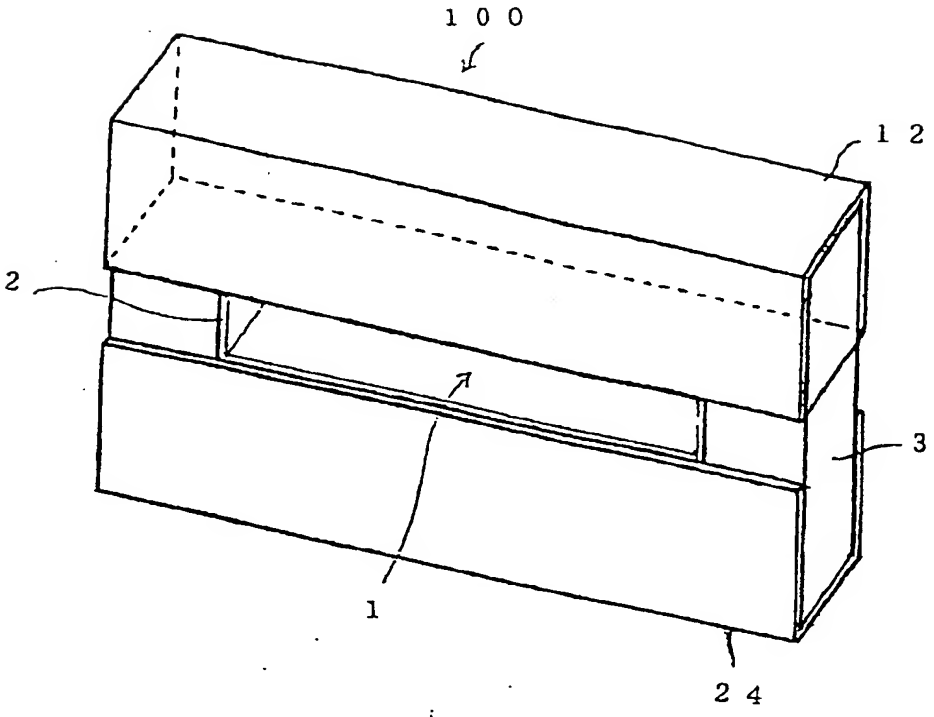

FIG. 7

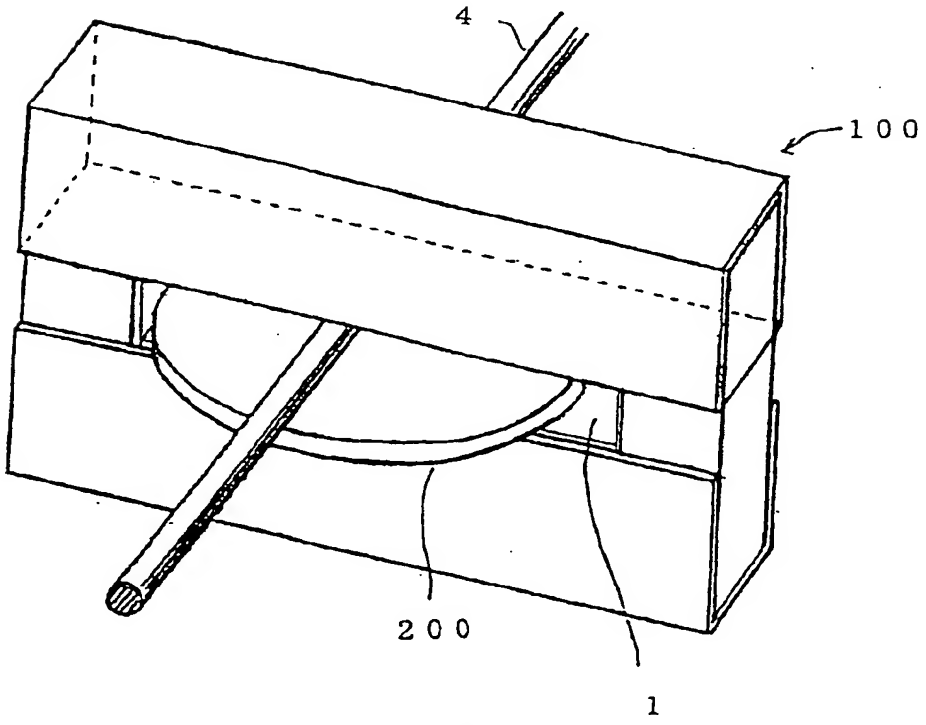

FIG. 8

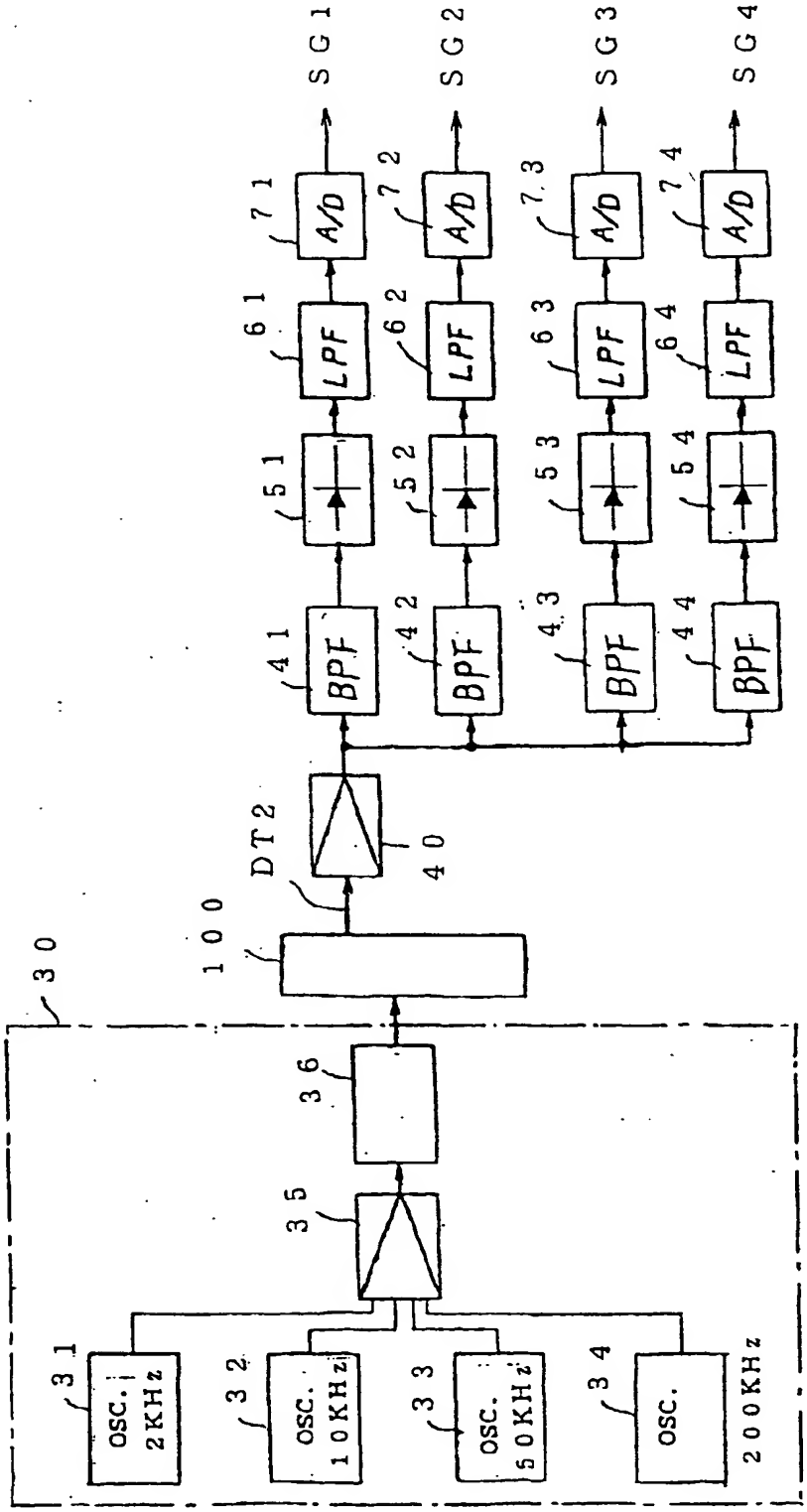
SG1
SG2
SG3
SG4
A/D
LPF
BPF
DT2
40
100
30
36
35
31
OSC. 2KHz
32
OSC. 10KHz
33
OSC. 50KHz
34
OSC. 200KHz

FIG. 9

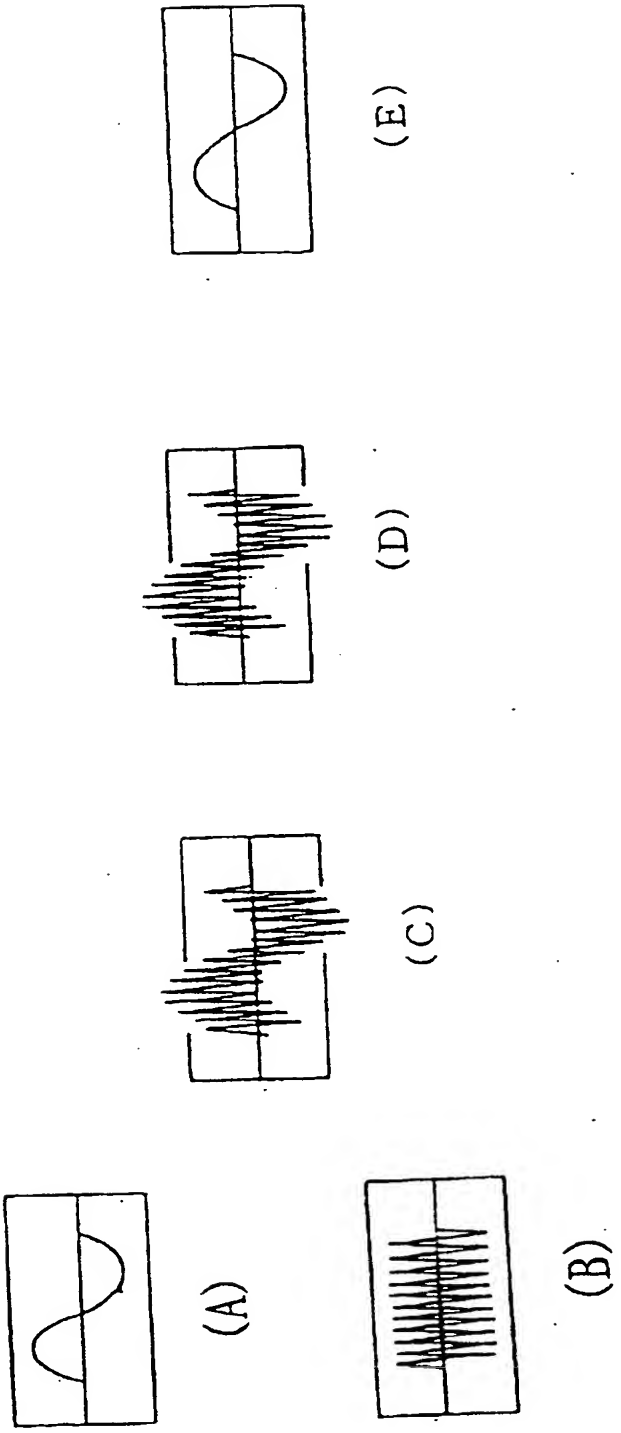

FIG. 10

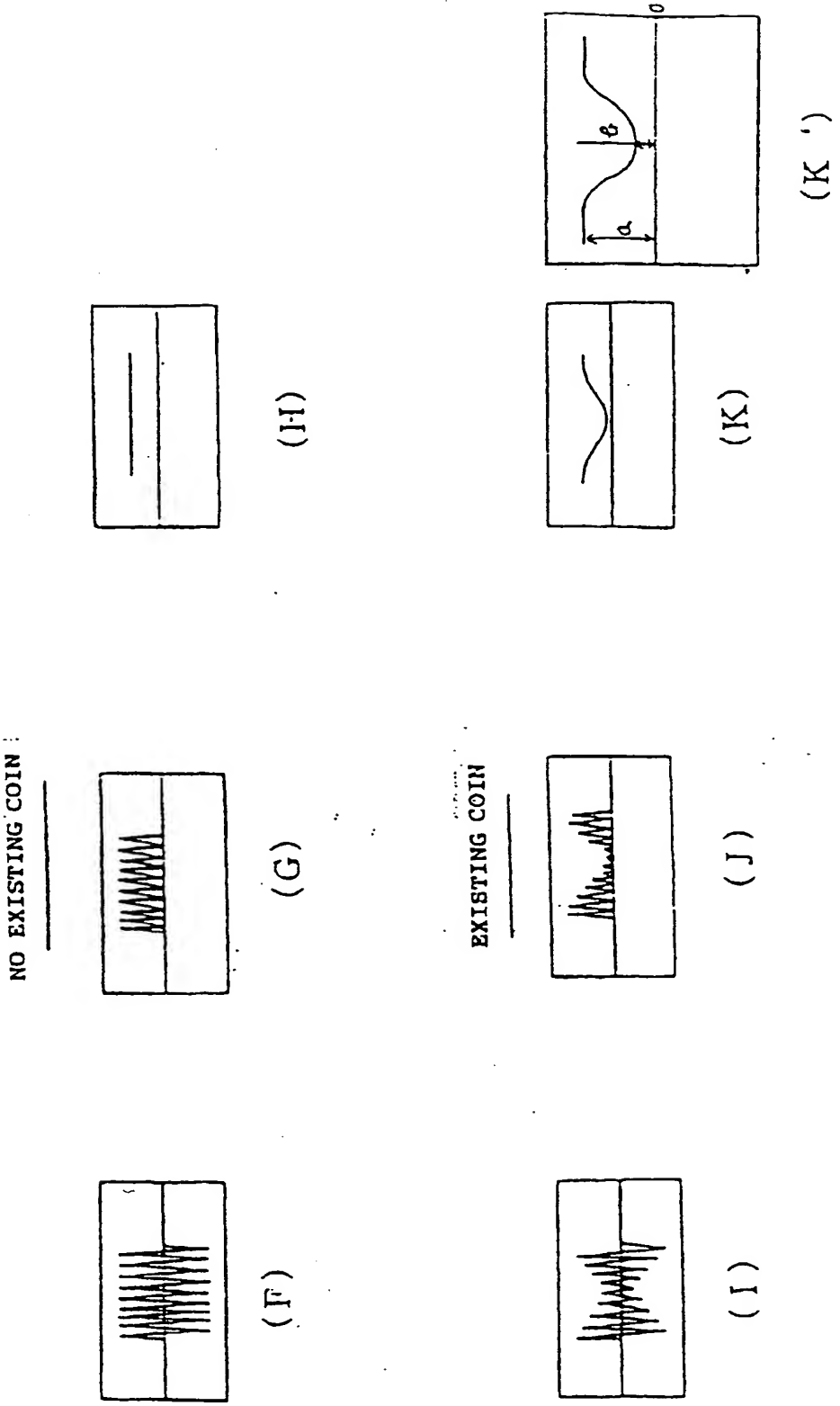

FIG. 11

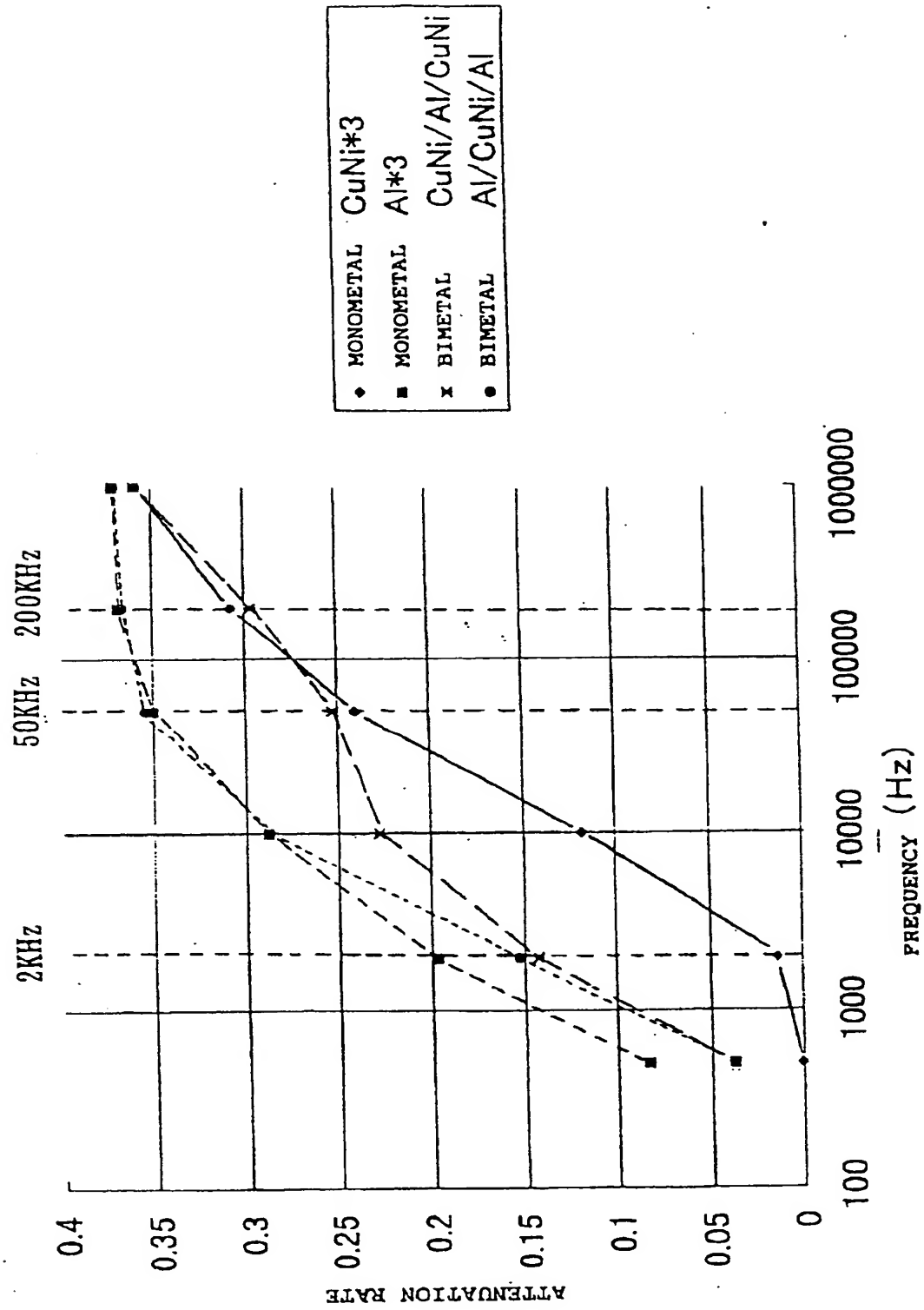
MONOMETAL CuNi*3
MONOMETAL Al*3
BIMETAL CuNi/Al/CuNi
BIMETAL Al/CuNi/Al
2KHz
50KHz
200KHz
ATTENUATION RATE
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
100
1000
10000
100000
1000000
FREQUENCY (Hz)

FIG. 12

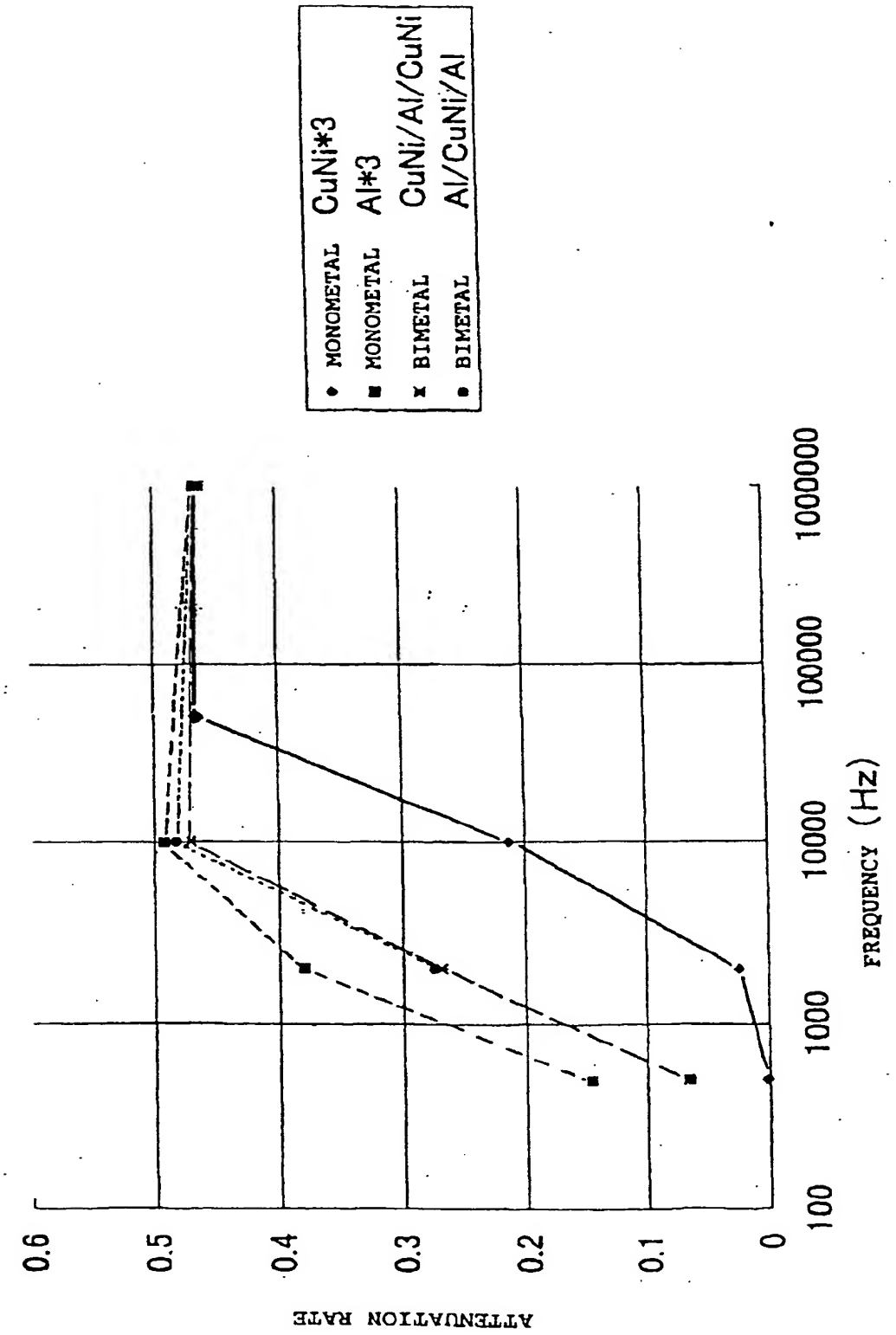
MONOMETAL CuNi*3
MONOMETAL Al*3
BIMETAL CuNi/Al/CuNi
BIMETAL Al/CuNi/Al
ATTENUATION RATE
0.6
0.5
0.4
0.3
0.2
0.1
0
100
1000
10000
100000
1000000
FREQUENCY (Hz)

FIG. 13

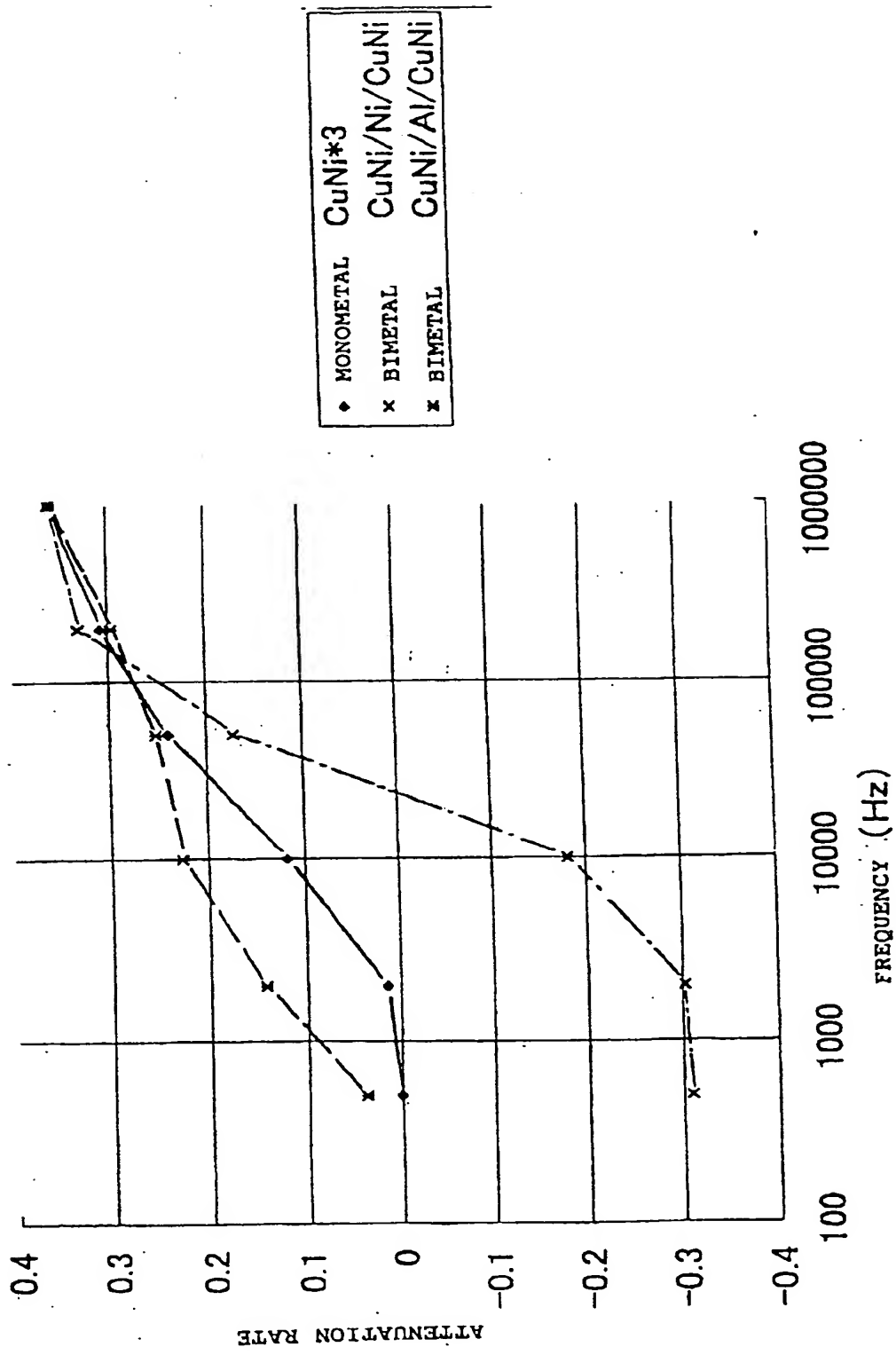
MONOMETAL CuNi*3
BIMETAL CuNi/Ni/CuNi
BIMETAL CuNi/Al/CuNi
ATTENUATION RATE
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
100
1000
10000
100000
1000000
FREQUENCY (Hz)

FIG. 14

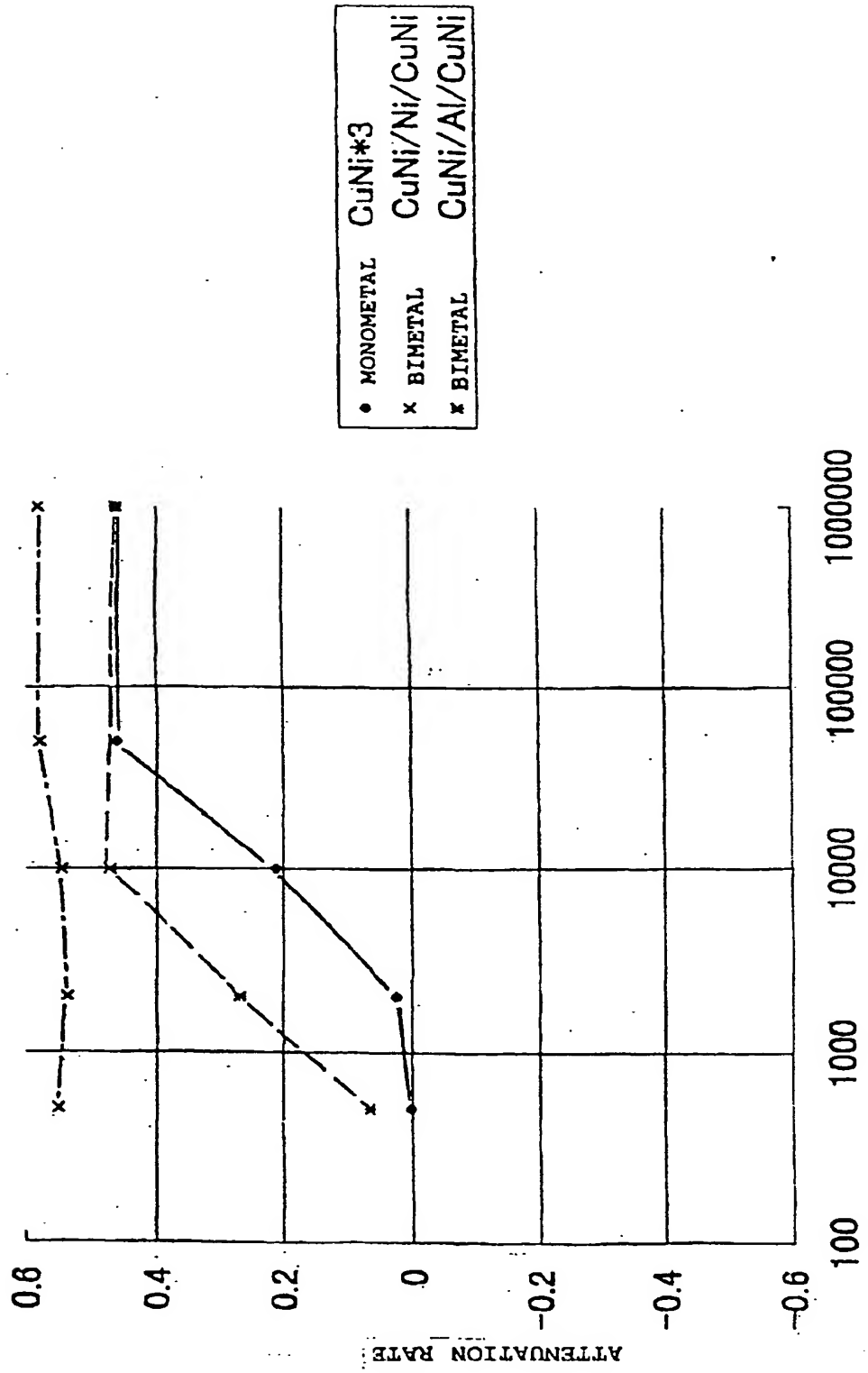
MONOMETAL CuNi*3
BIMETAL CuNi/Ni/CuNi
BIMETAL CuNi/Al/CuNi
ATTENUATION RATE
0.8
0.4
0.2
0
-0.2
-0.4
-0.6
100
1000
10000
100000
1000000
FREQUENCY (Hz)

FIG. 15

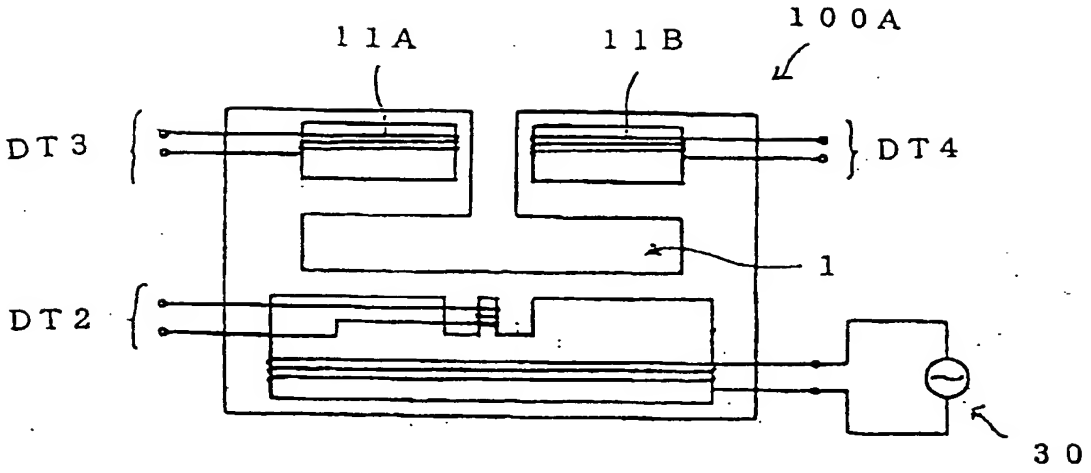

FIG. 16

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 20 4084

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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A	US 5 040 657 A (GUNN WILLIAM L ET AL) 20 August 1991 (1991-08-20) * column 6, line 34 - column 7, line 27 * * column 14, line 19 - column 15, line 16 * * figures 4A,8 *	1,2,5,7	TECHNICAL FIELDS SEARCHED (Int.Cl.7) G07D G07F
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 April 2000	Bocage, S

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& : member of the same patent family, corresponding document

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European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 20 4084

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 April 2000	Bocage, S

CATEGORY OF CITED DOCUMENTS

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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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& : member of the same patent family, corresponding document

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		IE 62093 B	14-12-1994
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